Coffee Creek: Hwy 66

NE NW SW
Section 29-14N-1W
Oklahoma County
Latitude North 35.65996°
Longitude West 97.33218°
WBID#: OK520710-01-0090C

Blue Thumb Volunteer Monitoring Data Review – December 2007
Written by Melinda West

The Coffee Creek watershed comprises approximately forty square miles in north central Oklahoma County. The stream originates in north Edmond in the region of Broadway and Coffee Creek Road. Flow is west to east on the west side of Interstate 35 then it turns to the southeast around Air Depot Road. It continues in a southeastern direction until it curves south to cross State Highway 66 just inside the Arcadia city limits. It turns back east and empties into the Deep Fork River less than one mile east of the Highway 66 bridge. Within the watershed are a golf course, several housing additions, forested and pasture lands, and the City of Edmond's water treatment plant.

The monitoring site is located at the point where Coffee Creek passes under the State Highway 66 bridge on the west side of Arcadia, Oklahoma. The creek makes an "S" curve under the bridge. Monthly chemical monitoring takes place on the south side of the bridge where the stream turns from south to east. A large amount of concrete "chunks" characterize the area, possibly belonging to an older railroad bridge. Fast water flow in this area has resulted in bank erosion primarily on the south side. The creek "sits" well below the level of the surrounding land and road. A lot of rocky debris in the creek bed creates riffles. The stream bed varies from relatively shallow and smooth clay and sand to deeper pools and very uneven rocky areas.

The State of Oklahoma Conservation Commission's **habitat assessment** adheres to a modified version of the EPA Rapid Bioassessment Protocols and is designed to assess habitat quality in relation to its ability to support biological communities in the stream. This assessment is based on parameters grouped into three categories. These categories include micro scale habitat, macro scale habitat, and riparian/bank structure. Micro scale habitat includes substrate makeup, stable cover, canopy, depth, and velocity. Macro scale assesses the channel morphology, sediment deposits, and other parameters. The third category looks at the riparian zone quality, width, and general makeup (trees, shrubs, vines, and grasses) as well as bank features. This section also includes bank erosion and streamside vegetative cover. These various features are scored on different scales. There are twenty possible points for "instream cover, pool bottom substrate, pool variability, canopy cover shading, presence of rocky runs or riffles, and flow." "Channel alteration and channel sinuosity" have 15 possible points each. "Bank stability, bank vegetation stability and streamside cover" each have a possible 10 points. The total habitat score can reach 180 points with the score increasing as habitat quality increases. No stream will score the highest value in every parameter. Streams in different ecoregions are very

different. Each stream should be compared to known high quality streams in the same ecoregion and vicinity.

Habitat assessment was conducted on a reach 400 meters upstream of the monthly monitoring site along a relatively straight west to east section of the stream north of the bridge. The habitat assessment score for the August 11, 2006 sample date was 87.9. The corresponding average score for high quality streams in the Cross Timbers ecoregion was 84.0.

Coffee Creek had a high score for pool variability, flow and streamside cover. **Pool variability** refers to the depths of the pools. Healthy diverse communities of aquatic organisms require both deep and shallow pools. **Flow** is representative of stream size. Habitat quality should rise as streams increase in size and discharge. **Streamside cover** is important in the transfer of food and energy into the stream. A mixture of grasses, forbs, shrubs, vines, saplings, and large trees make this transfer more efficient than would a single vegetative type.

Coffee Creek had several habitat parameters with moderate or mid level scores, such as: instream cover, percent of rocky runs and riffles, channel alteration, bank erosion, and bank stabilized with vegetation. **Instream cover** is the component of habitat that organisms hide behind, within or under. It consists of such items as submerged logs, cobbles and boulders, root wads and beds of aquatic plants. At least 50% of a stream's area should be occupied by a mixture of stable cover types for this category to be optimal. The **percent of rocky runs and riffles** was also in the mid score range. These provide highly oxygenated, turbulent water flowing over high quality cover and substrate. Aquatic organisms in these areas are some of the first to vanish when oxygen levels decrease. **Channel alteration** also had a mid level score. Unstable stream beds support fewer types of animals. Few or no signs of stream alteration are considered optimal. Due to the number of "objects" in the stream and flow rate, Coffee Creek's channel is often altered and **bank erosion** is a problem. **Banks stabilized with vegetation** benefit the aquatic community more than those stabilized with other materials such as rock or concrete. Stream bank vegetation provides a food source for aquatic animals.

Pool bottom substrate, canopy cover shading and channel sinuosity all had low scores. The **pool bottom substrate** does not provide the habitat necessary for bottom spawning fish and smaller vertebrates and invertebrates to successfully live and reproduce. Light in a stream is, of course, necessary for plant growth. **Canopy cover** moderates this light so the stream doesn't heat up too much. Aquatic organisms are more stressed by warm water, lower oxygen stability and higher metabolic rates that accompany warmer waters. The habitat assessment area is very straight, only curving at the area where it passes under the bridge. **Channel sinuosity** measures how far a channel deviates from a straight line. More sinuous channels tend to have more undercut banks, root wads, submerged logs, etc. thus providing more habitat.

Biological Conditions

Fish

Fish were collected by seine at the same time and from the same 400 meter section as the habitat assessment. The condition of the fish community is based on indices of species richness, community quality, trophic structure and by comparison to the average score for high quality streams in the same ecoregion.

The **total number of fish** species collected for Coffee Creek was 10 while the number for the average Cross Timbers high quality stream was nearly double at 19. The total number of species decreases with decreasing water or habitat quality. There were no **sensitive benthic species** such as darters, madtoms, and sculpins collected. These species decrease with increasing siltation and increasing benthic oxygen demand. These species are good indicators of conditions which make the microenvironment of the stream inhospitable. Only three **species of sunfish** were collected (bluegill, longear and unidentified young of the year). These decrease in number with decreasing pool quality and decreasing cover. They also require a fairly stable substrate for spawning. Their long term success is tied to conditions that affect the amount of sediment that enters and exits a stream. The number of sunfish species for the high quality Cross Timbers streams was 7. Only one **intolerant species of fish** was collected (suckermouth minnow.) Two were collected in Cross Timbers high quality streams. The **proportion of tolerant species** was 96% (70% for Cross Timbers high quality streams.) This characteristic separates moderate from low quality streams. These are opportunistic, tolerant fish that dominate communities that have lost their competitors through loss of habitat or water quality. Only 4% of the fish collected were **insectivorous cyprinids** (7% in the Cross Timbers high quality streams.) These fish increase as quality and quantity of the invertebrate food base increases.

The "overall score" for the fish community at the Coffee Creek site was a "D" while that of the Cross Timbers high quality streams was an "A" which indicates that top carnivores and many expected species were absent or rare while omnivores and tolerant species are dominant.

Macroinvertebrates

Collection of macroinvertebrates took place in the summers of 2005 and 2006 (July 1 – September 15) and winter 2007 (January 1 – March 15). These time periods represent seasons of relative community stqability providing an opportunity for meaningful site comparisons. Samples were taken from areas of rocky riffles at the monthly monitoring site.

Six metrics were used to assess the macroinvertebrate community. **Taxa richness** refers to the total number of different species. This number rises with increasing water and/or habitat quality. The winter 2006 sample had a score of 6 for this category as did the Cross Timbers high quality streams. The summer 2005 sample and both of the summer 2006 samples scored only 2 while the Cross Timbers high quality streams scored 6. The **EPT Index** is the number of different taxa from the orders Ephemeroptera (mayflies),

Plecoptera (stoneflies) and Trichoptera (caddisflies). Generally these insects are more sensitive to pollution than any other groups. As stream quality deteriorates members of this group are the first to disappear. The percent EPT is a measure of how many individuals in the sample are members of this group. This score helps to separate high quality streams from those of moderately high quality. The EPT taxa richness score for all samples at Coffee Creek were zero whereas the Cross Timbers high quality streams scored 6. **Percent dominant taxon** is the percentage of the collection composed of the most common taxon. As more species are excluded by increasing pollution, the remaining species increase in number. This helps separate the high quality streams from those of moderate quality. For winter 2006 the score for the percent contribution of dominants was 4 (2 for Cross Timbers high quality streams.) The summer 2005 and 2006 score was zero, whereas the summer 2006 replicate sample was 2 (Cross Timbers high quality streams scored 2.) **The Shannon-Weaver Species Diversity Index** measures the evenness of the species distribution. It increases as more and more taxa are found in the collection and as individual taxa become less dominant. The Shannon-Weaver Diversity Index was 4 for the winter 2006 sample and 2 for all other sampling periods. The Cross Timbers high quality streams scored 2.

The overall grades for Coffee Creek during the winter 2006 and summer 2006 "replicate" were "A" and "B" respectively. Attributes of an "A" condition are "comparable to the best situation expected within the ecoregion; balanced trophic and community structure for stream size." Attributes of a "B" are "community structure less than expected, species richness is less than expected due to loss of some intolerant forms, percent contribution of tolerant forms is increased." The summer 2006 and summer 2006 collections scored a "C." This condition has fewer species due to the loss of most intolerant forms.

Bacterial Testing

Fecal coliforms are a group of organisms common to the intestinal tracts of humans and other animals. Their presence is an indicator of pollution and potentially dangerous bacterial contamination. Bacterial testing for *E. coli* and total fecal coliforms, using Coliscan Easygel, was conducted July through September 2006 and May through September 2007 at the monthly monitoring site. According to Oklahoma's Water Quality Standards for **secondary body contact recreation** (i.e. ingestion not anticipated) the geometric mean of 10 coliform samples taken between May 1 and September 30 should not exceed 2000 colonies/100 ml or 25% or fewer of the individual samples shall not exceed 2000 colonies/100 ml. *E. coli* colonies should not exceed 630/100 ml. The values obtained for Coffee Creek are really too variable to draw any real conclusions. This variability could be due to the lack of experience that the sampler had with this technique. The source of this bacterial contamination could possibly be the sewage treatment plant, runoff from areas where cattle graze, birds roosting under the highway bridge or leaking septic systems upstream.

Bacterial Counts

Date	***E. coli* CFU*/100 ml**	**Fecal Coliform CFU/100 ml**
12 July 2006	1300	24600
15 August 2006	300	TNTC**
14 September 2006	100	TNTC
12 May 2007	5300	13800
9 June 2007	700	3800
15 July 2007	380	TNTC
11 August 2007	300	2700
15 September 2007	240	1740

*CFU = colony forming unit **TNTC – too numerous to count

Chemical Testing

Chemical data were collected monthly between June 3, 2006 and June 9, 2007. Eight chemical parameters were measured along with air and water temperature.

Dissolved oxygen saturation is a measure of the amount of oxygen available for aquatic life. At any given time the amount of oxygen in a stream depends on water temperature, partial pressure of oxygen in the atmosphere at water contact, the concentration of dissolved organic substances and physical aeration of the water. Both too little and too much oxygen can indicate problems. Dissolved oxygen (DO) for Coffee Creek ranged from 6 – 13 mg/L (milligrams/liter.) The corresponding percent oxygen saturation was 71 – 150% with a median value of 96% saturation. Normal is 80 – 130%. All of the values fell within the normal range with four exceptions; three slightly below 80% and one above 130%.

pH measures the hydrogen ions present in the water. It indicates how acidic or alkaline the water is. pH scale ranges from 0 to 14 with 7 being neutral. The normal pH range for

streams in Oklahoma is 6.5 to 9. Coffee Creek ranges from 7.3 to 8.0 with a median value of 7.75.

An estimate of **soluble nitrogen** is made by adding the amount of ammonia nitrogen and nitrate/nitrite nitrogen found in the water. The median value of soluble nitrogen for Coffee Creek is 3.74 mg/L N. The normal range for this parameter is 0 to 0.8 mg/L N, "caution" is 0.8 – 1.5 mg/L N, and "poor" is anything >1.5 mg/L N. The amount of these three sources of nitrogen varies a great deal at Coffee Creek. This could be due to the water treatment plant or to runoff from manure on pasturelands. Of the forty streams monitored by Blue Thumb in the Cross Timbers ecoregion, only one other (Okmulgee: Deep Fork Confluence) has as high and as wide a range of soluble nitrogen.

Phosphorus is measured as orthophosphate phosphorus in mg/L P. This, too, has a wide range at the Coffee Creek site (0.113 – 4.167 mg/L P.) Most creeks monitored in the Cross Timbers ecoregion have levels less than 2 mg/L P. Again, only Okmulgee: Deep Fork Confluence has as high a value as Coffee Creek and there was a known point source of pollution on Okmulgee Creek that has since been rerouted to the Deep Fork River. Anything above 0.1 mg/L will cause algal growth. The median value at Coffee Creek is 1.9 mg/L P.

Chloride is measured in mg/L. Coffee Creek ranges from 35 – 160mg/L Cl with a median value of 120 mg/L Cl. Chloride is a "natural" pollutant in much of Oklahoma due to the geology. The chloride content of the Deep Fork (into which Coffee Creek flows) approaches the maximum allowable under Safe Drinking Water standards. Possible sources, other than naturally occurring chloride, include septic waste, waste water treatment plant effluent, industrial and animal waste, fertilizer runoff, road salting/de-icing runoff, and oilfield operations.

"A water quality standard defines the water quality goals of a water body, or portion thereof, by designating the use or uses to be made of the water and by setting criteria necessary to protect the uses" (Code of Federal Regulations.) Water Quality Standards (WQS) are established to serve as goals for the water quality management plans. The Clean Water Act requires each state to develop and prepare WQS and at least once every three years it must review and evaluate existing standards and determine if they are appropriate or if modifications are needed. Oklahoma's Water Quality Standards are written by the Oklahoma Water Resources Board with input from many agencies (Oklahoma Conservation Commission, Oklahoma Corporation Commission, Oklahoma Department of Environmental Quality, Oklahoma Department of Mines, Oklahoma Department of Wildlife Conservation, Oklahoma State Department of Agriculture and the Office of the Secretary of the Environment.) The most recent EPA approved WQS for the state are found at
http://www.epa.gov/waterscience/standards/wqalibrary/ok/index.html.

Oklahoma's WQS are composed of three basic elements.

- **Beneficial uses:** a classification of the waters of the State according to their best uses in the interest of the public. Beneficial uses include: Public and Private Water Supply, Emergency Water Supply, Fish and Wildlife Propagation, Agriculture, Hydroelectric Power, Municipal and Industrial Process and Cooling Water, Primary Body Contact Recreation, Secondary Body Contact Recreation, Navigation, and Aesthetics.

- **Criteria to protect those uses:** numerical or narrative guides on the physical, chemical, or biological aspects, which will assure achievement of the designated use.

- **Antidegradation Policy:** a statement of the State's position on the use of waters, which are protected at levels considered above that required for beneficial use maintenance.

Two additional components involve special requirements set forth within the Standards document.

- **Compliance Schedules:** establish a reasonable time for new criteria to be implemented into permits.

- **Variances: allow for deviations from certain criteria for various reasons.**

The WQS are very long and written with a large amount of "jargon." From my understanding these are the standards for the parameters that Blue Thumb measures. For a *habitat limited aquatic community* (Coffee Creek was not habitat limited at the location and time of our assessment), dissolved oxygen should be at least 3.0 mg/L (4.0 mg/L from April 1 – June 15.) pH should be between 6.5 and 9.0. Chronic ammonia toxicity value varies with pH and temperature of the water. For temperatures and pH values reported the ammonia screening values range from 4.73 to 1.02 mg/L. Chloride should not exceed 250 mg/L. I could find no numerical values for nitrogen. The phosphorus water quality standard applies to waters designated as a Scenic River, which Coffee Creek is not.

The chemical parameters measured vary greatly at the Highway 66 Coffee Creek site. In an effort to understand this variation this stream was checked at a site upstream of the Edmond water treatment plant and one just downstream of the plant one day after sampling at the usual site.

Upstream and Downstream Results

Site	Coffee Creek Hwy 66 6 April 2006	Coffee Creek Blvd (upstream) 7 April 2006	Coffee Creek Danforth (downstream) 7 April 2006
pH	7.9	7.8	7.8
Nitrate	3 mg/L N	BDL	1.8 mg/L N
Nitrite	1 mg/L N	BDL	0.6 mg/L N

Ammonia	0.5 mg/L (dilution required)	BDL	2.5 mg/L
Orthophosphate	2.3 mg/L P	0.04 mg/L P	2 mg/L P
Chloride	140 mg/L Cl	120 mg/L Cl	120 mg/L Cl

mg/L = milligrams per liter BDL = below detection limit

The plant is operated under an Oklahoma Pollution Discharge Elimination System permit, issued by the Oklahoma Department of Environmental Quality (ODEQ.) The plant's current permit runs until February 1, 2009. During 2007, ODEQ conducted four plant inspections. The plant has a record of 100% compliance with all regulatory parameters for wastewater treatment. The process of wastewater treatment involves removal of carbonaceous organic material, oxidation of ammonia to nitrate, removal of nitrate and removal of phosphorus. The treated water is then filtered to remove remaining solids, chlorinated to kill any potentially harmful microorganisms, and de-chlorinated to eliminate excess chlorine that could be harmful to living organisms. The effluent is then discharged into Coffee Creek. According to the water resources superintendent, Fred Rice, the plant has never been out of compliance with its permit. The table below gives a summary of the permit with regard to parameters monitored by Blue Thumb.

The plant is not required to monitor phosphorus levels in the effluent. This is one parameter that usually has a high value at the monitoring site at Highway 66.

Edmond NPDES Permit

Effluent Characteristics	**Discharge Limitations Concentration (Mg/L)**		**Monitoring Requirements**
	30 day Average	7 day Average	
Spring (April-May)			
Ammonia (NH3-N)	4.1	9.9 (daily max.)	1/week
Fecal Coliform (May)	200 (geometric mean)	400 (daily max)	1/week
Dissolved Oxygen (DO)	Instantaneous Minimum	5	1/week
Summer (June - October)			
Ammonia (NH3-N)	3	5	1/week
Fecal Coliform	200 (geometric mean)	400 (daily max.)	1/week
Dissolved Oxygen (DO)	Instantaneous Minimum	4	1/week
Winter (November-March)			
Ammonia (NH3-N)	4.1	9.9 (daily max.)	1/week
Dissolved Oxygen (DO)	Instantaneous Minimum	5	1/week

Other year round requirements
No discharge of floating solids or visible foam in other than trace amounts
No discharge of any visible sheen of oil or globules of oil or grease
pH shall not be less than 6.5 nor more than 9.0 at any time, samples 4X/week

Overall, Coffee Creek at Highway 66 is a moderately healthy stream. The habitat assessment score of 87.9 indicates that the stream has the potential of being "healthy." Biological assessment of fish and macroinvertebrates indicate that the stream is beginning to have trouble. Life is there, but could be better if it was more diverse and had pollution sensitive organisms. The chemical data is "troubling." Without the wide fluctuations and high values of P, N and Cl this stream could be very healthy. The question is, "What is the source of these chemicals?" It is not clear to me that the wastewater plant is this source. It very well could be, but I don't think we have the data to support that. The one set of data from extra sampling sites done in spring 2006 is just not enough. After having sampled the creek for over a year now, I can confirm that the parameters are too variable to rely on just one set. Because Coffee Creek flows through many types of land use it is possible there are other sources of pollution (leaking septic systems, over fertilization of lawns and fields, manure from agricultural use, etc.). The fact that ODEQ is sent a copy of the monthly sampling results and has never inquired about them (to my knowledge) leads me to believe the values are within Oklahoma's water quality standards. Perhaps the problem lies with the standards. To adequately address this situation a series of sampling sites above and below the plant would need to be sampled for at least a year. Land usage of the surrounding areas would need to be noted. I think this would be a good project for a high school or college biology, chemistry or ecology class.